

AMENDMENT TO THE CLAIMS

I. (Currently Amended) A multi-beam scanning optical apparatus

comprising:

incident optical means for making a plurality of light beams emitted from light source means having a plurality of light emitting portions incident on deflection means; and

scanning optical means for forming images of the plurality of light beams deflected by said deflection means on a surface to be scanned,

C wherein said scanning optical means has at least one scanning optical element made of a resin, and said scanning optical element made of the resin has birefringence due to a stress distribution generated upon cooling in a molding process thereof such that the directions of principal axes of birefringence at one end portion of said scanning optical element made of the resin are different from those at the other end portion, opposite to said one end portion with respect to an optical axis thereof in a main scanning direction, of said scanning optical element made of the resin, and

wherein an interval between adjacent scanning lines of scanning lines formed on the scanned surface by the plurality of light beams whose images are formed on the scanned surface through said scanning optical element made of the resin changes in the main scanning direction in an effective scanning region, and

D wherein said apparatus comprises at least one setting means for setting an interval error between scanning lines in a sub-scanning line direction, the interval error being caused by a relation in which ~~polarization angles~~ ^{directions} polarized light beams of the light

beams emitted from the plurality of light emitting portions are not parallel or orthogonal with each other, to be not more than 1/5 of a desired scanning line interval.

2. (Previously Presented) An apparatus according to claim 1, wherein the directions of the principal axes of the birefringence at the end portions of said scanning optical element made of the resin form an asymmetrical distribution due to the stress distribution generated upon cooling in the molding process of said scanning optical element made of the resin.

C' cont.
3. (Original) An apparatus according to claim 1, wherein said apparatus has a plurality of scanning optical elements made of the resin.

4. (Original) An apparatus according to claim 1, wherein said scanning optical means includes refractive optical elements all of which are scanning optical elements made of a resin.

5. (Original) An apparatus according to claim 1, wherein said scanning optical means includes a scanning optical element made of glass.

6. (Original) An apparatus according to claim 1, wherein said scanning optical means includes a reflecting optical element having a power.

7. (Original) An apparatus according to claim 1, wherein said setting means sets the polarization angle difference between the light beams emitted from the plurality of light emitting portions to be not more than 20°.

8. (Original) An apparatus according to claim 1, wherein said setting means comprises correction means for correcting the polarization angle difference between the plurality of light beams incident on said scanning optical element made of the resin.

C. cont.
9. (Original) An apparatus according to claim 8, wherein said correction means comprises polarized light limiting means inserted into an optical path between the light source means and said scanning optical element made of the resin.

10. (Original) An apparatus according to claim 9, wherein said polarized light limiting means is tilted with respect to the optical axis of said incident optical means.

11. (Original) An apparatus according to claim 1, wherein the plurality of light emitting portions are independently arranged.

12. (Original) An apparatus according to claim 11, wherein said setting means comprises adjustment means capable of independently adjusting polarization angles of the light beams emitted from the plurality of light emitting portions.

13. (Original) An apparatus according to claim 1, wherein the light source means comprises a monolithic multi-beam light source.

14. (Original) An apparatus according to claim 13, wherein said apparatus has a plurality of monolithic multi-beam light sources.

15. (Original) An apparatus according to claim 14, wherein said setting means comprises adjustment means capable of independently adjusting polarization angles of the light beams emitted from the plurality of monolithic multi-beam light sources.

C' cont.

16. (Previously Presented) An apparatus according to claim 1, wherein said setting means comprises a scanning optical element made of a resin, which is shift-decentered perpendicularly to a sub scanning direction.

17. (Original) An apparatus according to claim 1, wherein letting h be a sub-scanning width of said scanning optical element made of the resin and d be an optical-axis-direction width, $h/d \leq 1.8$ is satisfied.

18. (Original) An apparatus according to claim 1, wherein letting h be a sub-scanning width of said scanning optical element made of the resin and t be a sub-scanning width of the light beam passing through said scanning optical element made of the resin, $h/t \leq 15$ is satisfied.

19. (Previously Presented) An image forming apparatus comprising:
a multi-beam scanning optical apparatus according to claim 1;
a photosensitive member disposed in the scanned surface;
a developer for developing, as a toner image, an electrostatic latent image
formed on said photosensitive member by light beams scanned by said multi-beam
scanning optical apparatus;
a transfer device for transferring the developed toner image onto a recording
medium; and
a fixing device for fixing the transferred toner image on the recording
medium.

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cont.

20. (Previously Presented) An image forming apparatus comprising:
said multi-beam scanning optical apparatus of claim 1; and
a printer controller for converting code data received from an external
device into an image signal and inputting the image signal to said scanning optical
apparatus.

21. to 23. (Canceled)

²³
24. (Previously Presented) A multi-beam scanning optical apparatus
comprising:

incident optical means for making a plurality of light beams emitted from light source means having a plurality of light emitting portions incident on deflection means; and

scanning optical means for forming images of the plurality of light beams deflected by said deflection means on a surface to be scanned,

wherein said scanning optical means has at least one scanning optical element made of a resin, and said scanning optical element made of the resin has birefringence due to a stress distribution generated upon cooling in a molding process thereof such that the directions of principal axes of birefringence at one end portion of said scanning optical element made of the resin are different from those at the other end portion, opposite to said one end portion with respect to an optical axis thereof in a main scanning direction, of said scanning optical element made of the resin, and

wherein an interval between adjacent scanning lines of scanning lines formed on the scanned surface by the plurality of light beams whose images are formed on the scanned surface through said scanning optical element made of the resin changes in the main scanning direction in an effective scanning region, and

said apparatus comprises at least one setting means for setting a sub-scanning interval error between the scanning lines due to a polarization angle difference between the light beams emitted from the plurality of light emitting portions to be not more than 1/5 of a desired scanning line interval,

said setting means comprising correction means for correcting the polarization angle difference between the plurality of light beams incident on said scanning optical element made of the resin, and

wherein said setting means comprises adjustment means capable of independently adjusting polarization angles of light beams emitted from the plurality of light emitting portions.

25. to 31. (Canceled)

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C. cont.
32. (Previously Presented) A multi-beam scanning optical apparatus comprising:

incident optical means for making a plurality of light beams emitted from light source means having a plurality of light emitting portions incident on deflection means; and

scanning optical means for forming images of the plurality of light beams deflected by said deflection means on a surface to be scanned,

wherein said scanning optical means has at least one scanning optical element made of a resin, and said scanning optical element made of the resin has birefringence due to a stress distribution generated upon cooling in a molding process thereof such that the directions of principal axes of birefringence at one end portion of said scanning optical element made of the resin are different from those at the other end portion,

opposite to said one end portion with respect to an optical axis thereof in a main scanning direction, of said scanning optical element made of the resin, and

wherein an interval between adjacent scanning lines of scanning lines formed on the scanned surface by the plurality of light beams whose images are formed on the scanned surface through said scanning optical element made of the resin changes in the main scanning direction in an effective scanning region, and

C. cont.
said apparatus comprises at least one setting means for setting an actual sub-scanning interval error between the scanning lines on the scanning surface to be smaller than the sub-scanning interval error between the scanning lines on the scanned surface, caused by a relative displacement in polarization angle between the light beams emitted from the plurality of light emitting portions,

said setting means comprising a scanning optical element made of a resin, which is shift-decentered perpendicularly to a sub scanning direction.

25/ 33. (Previously Presented) An image forming apparatus comprising:
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a multi-beam scanning optical apparatus according to claim 32;
a photosensitive member disposed in the scanned surface;
a developer for developing, as a toner image, an electrostatic latent image formed on said photosensitive member by light beams scanned by said multi-beam scanning optical apparatus;
a transfer device for transferring the developed toner image onto a recording medium; and

a fixing device for fixing the transferred toner image on the recording medium.

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~~34.~~ (Original) An image forming apparatus comprising:
said multi-beam scanning optical apparatus of claim ²⁴~~32~~, and
a printer controller for converting code data received from an external device into an image signal and inputting the image signal to said scanning optical apparatus.

C' cont.
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~~35.~~ (Previously Presented) A multi-beam scanning optical apparatus comprising:
incident optical means for making a plurality of light beams emitted from light source means having a plurality of light emitting portions incident on deflection means; and

scanning optical means for forming images of the plurality of light beams deflected by said deflection means on a surface to be scanned,

wherein said scanning optical means has at least one scanning optical element made of a resin, and said scanning optical element made of the resin has birefringence due to a stress distribution generated upon cooling in a molding process thereof such that the directions of principal axes of birefringence at one end portion of said scanning optical element made of the resin are different from those at the other end portion,

opposite to said one end portion with respect to an optical axis thereof in a main scanning direction, of said scanning optical element made of the resin, and

wherein an interval between adjacent scanning lines of scanning lines formed on the scanned surface by the plurality of light beams whose images are formed on the scanned surface through said scanning optical element made of the resin changes in the main scanning direction in an effective scanning region, and

C cont. said apparatus comprises at least one setting means for setting an actual sub-scanning interval error between the scanning lines on the scanned surface to be smaller than the sub-scanning interval error between the scanning lines on the scanned surface, caused by a relative displacement in polarization angle between the light beams emitted from the plurality of light emitting portions,

said setting means comprising polarized light limiting means inserted into an optical path between the light source means and said scanning optical element made of the resin.

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36. (Previously Presented) An image forming apparatus comprising:
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a multi-beam scanning optical apparatus according to claim 35;
a photosensitive member disposed in the scanned surface;
a developer for developing, as a toner image, an electrostatic latent image formed on said photosensitive member by light beams scanned by said multi-beam scanning optical apparatus;

a transfer device for transferring the developed toner image onto a recording medium; and

a fixing device for fixing the transferred toner image on the recording medium.

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37. (Original) An image forming apparatus comprising:
said multi-beam scanning optical apparatus of claim 36²¹; and

a printer controller for converting code data received from an external device into an image signal and inputting the image signal to said scanning optical apparatus.

C' cont.
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38. (Currently Amended) A multi-beam scanning optical apparatus comprising:

an incident optical system for making a plurality of light beams emitted from a light source having a plurality of light emitting portions incident on a deflector;

a scanning optical system for forming images with the plurality of light beams deflected by the deflector on a surface to be scanned, said scanning optical system having a plurality of scanning optical elements each made of a resin; and

at least one setting means for setting an interval error between scanning lines in a sub-scanning line direction, the interval error being caused by a relation in which ^{directions} ~~polarization angles~~ polarized light beams of the light beams emitted from the plurality of

light emitting portions are not parallel or orthogonal with each other, to be not more than 1/5 of a desired scanning line interval.

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~~39~~. (Previously Presented) An apparatus according to claim ³³~~38~~, wherein said scanning optical system includes a reflecting optical element having a power.

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~~40~~. (Previously Presented) An apparatus according to claim 38, wherein said setting means sets the polarization angle difference between the light beams emitted from the plurality of light emitting portions to be not more than 20°.

C' cont.
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~~41~~. (Previously Presented) An apparatus according to claim ³³~~38~~, wherein said setting means comprises a correction system for correcting the polarization angle difference between the plurality of light beams incident on the plurality of scanning optical elements made of the resin.

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~~42~~. (Previously Presented) An apparatus according to claim ³⁶~~41~~, wherein the correction system comprises a polarized light limiter inserted into an optical path between the light source and the plurality of scanning optical elements made of the resin.

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~~43~~. (Previously Presented) An apparatus according to claim ³⁷~~42~~, wherein said polarized light limiter is tilted with respect to an optical axis of said incident optical system.

39 44. (Previously Presented) An apparatus according to claim 38, wherein the plurality of light emitting portions are independently arranged.

40 45. (Previously Presented) An apparatus according to claim 38, wherein said setting means comprises an adjustment system capable of independently adjusting polarization angles of the light beams emitted from the plurality of light emitting portions.

41 46. (Previously Presented) An apparatus according to claim 38, wherein the light source comprises a monolithic multi-beam light source.

C. cnt. 42 47. (Previously Presented) An apparatus according to claim 46, wherein said apparatus has a plurality of monolithic multi-beam light sources.

43 48. (Previously Presented) An apparatus according to claim 47, wherein said setting means comprises an adjustment system capable of independently adjusting polarization angles of the light beams emitted from the plurality of monolithic multi-beam light sources.

44 49. (Previously Presented) An apparatus according to claim 38, wherein said setting means comprises a scanning optical element made of a resin, which is shift-decentered perpendicularly to a sub-scanning direction.

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50. (Previously Presented) An apparatus according to claim 38, wherein
letting h be a sub-scanning width of the plurality of scanning optical elements made of the
resin and d be an optical-axis-direction width thereof, $h/d \leq 1.8$ is satisfied.

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51. (Previously Presented) An apparatus according to claim 38, wherein
letting h be a sub-scanning width of the plurality of scanning optical elements made of the
resin and t be a sub-scanning width of the light beam passing through the plurality of
scanning optical elements made of the resin, $h/t \leq 15$ is satisfied.

C' cont.
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52. (Previously Presented) An image forming apparatus comprising:
a multi-beam scanning optical apparatus according to claim 38;
a photosensitive member disposed in the scanned surface;
a developer for developing, as a toner image, an electrostatic latent image
formed on said photosensitive member by light beams scanned by said multi-beam
scanning optical apparatus;
a transfer device for transferring the developed toner image onto a recording
medium; and
a fixing device for fixing the transferred toner image on the recording
medium.

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53. (Previously Presented) An image forming apparatus comprising:
a multi-beam scanning optical apparatus according to claim 38; and

a printer controller for converting code data received from an external device into an image signal and inputting the image signal to said multi-beam scanning optical apparatus.

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54. (Currently Amended) A multi-beam scanning optical apparatus comprising:

an incident optical system for making a plurality of light beams emitted from a light source having a plurality of light emitting portions incident on a deflector;

C cont.
a scanning optical system for forming images of the plurality of light beams deflected by the deflector on a surface to be scanned, said scanning optical system having refractive optical elements all of which are scanning optical elements each made of a resin; and

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at least one setting means for setting an interval error between scanning lines in a sub-scanning line direction, the interval error being caused by a relation in which ^{directions} ~~polarization angles~~ polarized light beams of the light beams emitted from the plurality of light emitting portions are not parallel or orthogonal with each other, to be not more than 1/5 of a desired scanning line interval.

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56. (Previously Presented) An apparatus according to claim 54, wherein
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said scanning optical system includes a reflecting optical element having a power.

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56. (Previously Presented) An apparatus according to claim 54, wherein said setting means sets the polarization angle difference between the light beams emitted from the plurality of light emitting portions to be not more than 20°.

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57. (Previously Presented) An apparatus according to claim 54, wherein said setting means comprises a correction system for correcting the polarization angle difference between the plurality of light beams incident on the scanning optical elements made of the resin.

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C. cont.
58. (Previously Presented) An apparatus according to claim 57, wherein the correction system comprises a polarized light limiter inserted into an optical path between the light source and the scanning optical elements made of the resin.

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59. (Previously Presented) An apparatus according to claim 58, wherein the polarized light limiter is tilted with respect to an optical axis of said incident optical system.

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60. (Previously Presented) An apparatus according to claim 54, wherein the plurality of light emitting portions are independently arranged.

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61. (Previously Presented) An apparatus according to claim 54, wherein
said setting means comprises an adjustment system capable of independently adjusting
polarization angles of the light beams emitted from the plurality of light emitting portions.

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62. (Previously Presented) An apparatus according to claim 54, wherein the
light source comprises a monolithic multi-beam light source.

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63. (Previously Presented) An apparatus according to claim 62, wherein
said apparatus has a plurality of monolithic multi-beam light sources.

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64. (Previously Presented) An apparatus according to claim 63, wherein
said setting means comprises an adjustment system capable of independently adjusting
polarization angles of the light beams emitted from the plurality of monolithic multi-beam
light sources.

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65. (Previously Presented) An apparatus according to claim 54, wherein
said setting means comprises a scanning optical element made of a resin, which is
shift-decentered perpendicularly to a sub-scanning direction.

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66. (Previously Presented) An apparatus according to claim 54, wherein
letting h be a sub-scanning width of the scanning optical elements made of the resin and d
be an optical-axis-direction width thereof, $h/d \leq 1.8$ is satisfied.

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67. (Previously Presented) An apparatus according to claim 54, wherein
letting h be a sub-scanning width of the scanning optical elements made of the resin and t
be a sub-scanning width of the light beam passing through the scanning optical elements
made of the resin, $h/t \leq 15$ is satisfied.

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68. (Previously Presented) An image forming apparatus comprising:
a multi-beam scanning optical apparatus according to claim 54;
a photosensitive member disposed in the scanned surface;
a developer for developing, as a toner image, an electrostatic latent image
formed on said photosensitive member by light beams scanned by said multi-beam
scanning optical apparatus;
a transfer device for transferring the developed toner image onto a recording
medium; and
a fixing device for fixing the transferred toner image on the recording
medium.

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69. (Previously Presented) An image forming apparatus comprising:
a multi-beam scanning optical apparatus according to claim 54; and
a printer controller for converting code data received from an external
device into an image signal and inputting the image signal to said multi-beam scanning
optical apparatus.

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70. (Previously Presented) An apparatus according to any one of claims 24, 32 and 38, wherein said scanning optical system has a plurality of scanning optical elements each made of a resin.

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71. (Previously Presented) An apparatus according to any one of claims 24, 32 and 38, wherein said scanning optical system has refractive optical elements all of which are the scanning optical elements each made of the resin.

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72. (Previously Presented) An apparatus according to claim 1, wherein said setting means comprises a scanning optical element made of a resin, which is rotary-decentered about the main scanning direction.

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73. (Previously Presented) An apparatus according to claim 1, wherein said setting means comprises a scanning optical element made of a resin, which is shift-decentered perpendicularly to a sub scanning direction and rotary-decentered about the main scanning direction.

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74. (Previously Presented) A multi-beam scanning optical apparatus comprising:
incident optical means for making a plurality of light beams emitted from light source means having a plurality of light emitting portions incident on deflection means; and

scanning optical means for forming images of the plurality of light beams deflected by said deflection means on a surface to be scanned,

wherein said scanning optical means has at least one scanning optical element made of a resin, and said scanning optical element made of the resin has birefringence due to a stress distribution generated upon cooling in a molding process thereof such that the directions of principal axes of birefringence at one end portion of said scanning optical element made of the resin are different from those at the other end portion, opposite to said one end portion with respect to an optical axis thereof in a main scanning direction, of said scanning optical element made of the resin, and

C' cont.
wherein an interval between adjacent scanning lines of scanning lines formed on the scanned surface by the plurality of light beams whose images are formed on the scanned surface through said scanning optical element made of the resin changes in the main scanning direction in an effective scanning region, and

said apparatus comprises at least one setting means for setting an actual sub-scanning interval error between the scanning lines on the scanning surface to be smaller than the sub-scanning interval error between the scanning lines on the scanned surface, caused by a relative displacement in polarization angle between the light beams emitted from the plurality of light emitting portions,

said setting means comprising a scanning optical element made of a resin, which is rotary-decentered about the main scanning direction.

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73. (Previously Presented) A multi-beam scanning optical apparatus

comprising:

incident optical means for making a plurality of light beams emitted from light source means having a plurality of light emitting portions incident on deflection means; and

scanning optical means for forming images of the plurality of light beams deflected by said deflection means on a surface to be scanned,

wherein said scanning optical means has at least one scanning optical element made of a resin, and said scanning optical element made of the resin has birefringence due to a stress distribution generated upon cooling in a molding process thereof such that the directions of principal axes of birefringence at one end portion of said scanning optical element made of the resin are different from those at the other end portion, opposite to said one end portion with respect to an optical axis thereof in a main scanning direction, of said scanning optical element made of the resin, and

wherein an interval between adjacent scanning lines of scanning lines formed on the scanned surface by the plurality of light beams whose images are formed on the scanned surface through said scanning optical element made of the resin changes in the main scanning direction in an effective scanning region, and

said apparatus comprises at least one setting means for setting an actual sub-scanning interval error between the scanning lines on the scanning surface to be smaller than the sub-scanning interval error between the scanning lines on the scanned

C' cont.

surface, caused by a relative displacement in polarization angle between the light beams emitted from the plurality of light emitting portions,

said setting means comprising a scanning optical element made of a resin, which is shift-decentered perpendicularly to a sub scanning direction and rotary-decentered about the main scanning direction.

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76. (Currently Amended) A multi-beam scanning optical apparatus
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according to any one of claims 32, 74, and 75, wherein said setting means sets an interval error between scanning lines in a sub-scanning line direction, the interval error being caused by a relation in which ^{directions} ~~polarization angles~~ polarized light beams of the light beams emitted from the plurality of light emitting portions are not parallel or orthogonal with each other, to be not more than 1/5 of a desired scanning line interval.

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77. (Currently Amended) A multi-beam scanning optical apparatus
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according to claim 35, wherein said setting means sets an interval error between scanning lines in a sub-scanning line direction, the interval error being caused by a relation in which ^{directions} ~~polarization angles~~ polarized light beams of the light beams emitted from the plurality of light emitting portions are not parallel or orthogonal with each other, to be not more than 1/5 of a desired scanning line interval.

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78. (Previously Presented) An apparatus according to claim 38, wherein said setting means comprises a scanning optical element made of a resin, which is rotary-decentered about a main-scanning direction.

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79. (Previously Presented) An apparatus according to claim 38, wherein said setting means comprises a scanning optical element made of a resin, which is shift-decentered perpendicularly to a sub-scanning direction and rotary-decentered about a main-scanning direction.

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cont.

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80. (Previously Presented) An apparatus according to claim 54, wherein said setting means comprises a scanning optical element made of a resin, which is rotary-decentered about the main-scanning direction.

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81. (Previously Presented) An apparatus according to claim 54, wherein said setting means comprises a scanning optical element made of a resin, which is shift-decentered perpendicularly to a sub-scanning direction and rotary-decentered about the main-scanning direction.